RAPID MEDICAL MODEL DEVELOPMENT USING NEURAL NETWORKS

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INTRODUCTION

Neural networks (NN)s in medicine have been used for classification, image segmentation and outcome prediction in medicine(1). The use of NNs in medicine has been limited by the difficulty of determining good NN architectures and data transformations for specific problem domains. In this poster, we test the ability to use a rapid NN development program for the prediction of contrast enhancement with spiral CT of the liver. We compared rapidly developed NN models with statistical models based on analysis of covariance (ANCOVA).

METHODS

The artificial NNs were constructed using PREDICT (Neural Works Pittsburgh, PA). This NN development package was chosen as it allows rapid development of a feedforward supervised network algorithm. This program uses a genetic algorithm to search good sets of input variables and input transformations for the network. Genetic algorithms use a combination of random change and selection of the best solutions in a population to arrive at a good solution to a problem.

The NN itself is produced using a cascade method of network construction together with a choice of two possible learning rules. In this study, the adaptive gradient learning rule was used. This algorithm also uses a test data set while training the NN in order to reduce over fitting and improve generalization.

A data set concerning liver enhancement after injection of different types of contrasts at different time intervals was used to study NN rapid model development(2). Net liver enhancement was predicted using rapidly developed NNs. Ten to twenty percent of the data set was randomly selected to validate the NN model. ANCOVA was used on the same data sets and its predictions were compared with the NNs.

RESULTS

Table I shows the average error (actual - predicted) for the 10 NN models and 10 ANCOVA models for net liver enhancement. For two runs ANCOVA had significantly lower mean absolute errors and for two runs the NN had significantly lower mean absolute errors.

Table I
Average Error and p-values

Run #[n]	ANCOVA	NN	Abs Diff p-value
1 [17]	-0.50 (2.3)	0.77 (2.4)	0.50
2 [16]	2.0 (2.4)	1.5 (2.2)	0.07
3 [19]	0.07 (2.0)	1.7 (2.1)	0.69
4 [21]	-0.46 (2.1)	-0.94 (2.2)	0.48
5 [14]	1.9 (2.4)	-2.7 (2.3)	0.80
6 [21]	-0.43 (2.1)	0.18 (2.1)	0.64
7 [22]	2.7 (2.2)	4.7 (2.9)	0.002
8 [24]	-3.5 (2.5)	2.5 (2.2)	0.007
9 [26]	0.49 (2.3)	4.7 (2.5)	0.17
10 [14]	-1.9 (2.4)	-8.0 (3.6)	0.03

Overall, there were 3 runs for which the NN had smaller mean absolute error than ANCOVA, and seven runs with the opposite. Using a binomial distribution, this difference (30% versus 70%) is not statistically significant (p=34).

CONCLUSION

In this data set ANCOVA and rapidly developed NN models demonstrated no significant difference in predicting net liver enhancement with contrast. Further research is needed to determine if rapidly developed NN models can perform as good as or better than statistical methods in medical model development

REFERENCES

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2. Use of Contrast Material for Spiral CT of the Abdomen: Comparison of Hepatic Enhancement and Vascular Attenuation for Three Different Contrast Media at Two Different Delay Times, AJR 1995; 164:327-331.